

ENGINEERING CASE LIBRARY

## AMERICAN TRACTOR EQUIPMENT CORPORATION (A)

## Development of a Parallel Lift Ripper

"My company, which sells three to four million dollars worth of equipment per year, is in competition with much larger companies such as Allis-Chalmers\* and the Caterpillar Tractor Company\*\*, " said Mr. A. W. Kant, vice president of the American Tractor Equipment Corporation. "However, I feel that we have an advantage over our competitors in that we concentrate our design efforts only on rippers and related equipment."

Rippers are large metal claws which are pulled by tractors and used in the heavy construction industry to break up such materials as rock, hard soil, and pavement (Exhibit 1). For economic reasons, ripping has to a large extent replaced blasting as a way of breaking up material into a form that can be removed with scrapers. Rippers are also used to lay underground cables and to loosen up ground ahead of trench digging machines.

"We believe we have a reputation of leading the field in ripper design," said Mr. R. L. Sprenkel, the chief engineer. "However, we have made a few design mistakes, and I think that the pressure from our sales department to keep ahead of our competitors has been a factor in making some of them. My department has recently completed corrective design work on a part failure that occurred in one of our parallel rippers. This failure cost the company a considerable amount of money, and the management was pretty unhappy. We were all lulled into a false sense of security on this particular design by a successful test of the prototype."

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\* gross sales in 1964: \$632 million

\*\* gross sales in 1964: \$1,161 million

(c) 1965 by the Board of Trustees of Leland Stanford Junior University.  
Prepared in the Design Division of the Department of Mechanical Engineering  
by David A. Horine under the direction of H. O. Fuchs with financial support  
from the National Science Foundation.

### The Company

ATECO has been making rippers since 1920, and, according to Mr. Sprenkel, it has been a pioneer in the design of earth moving equipment. "Our past president, Mr. Wooldridge, designed and built rippers before most of the present heavy construction companies, such as Caterpillar and Le Tourneau, entered the field," said Mr. Sprenkel. "His basic philosophy was 'build what the contractor needs'; ATECO was willing to design and build as few as one or two units to satisfy a contractor's special request. This special service to contractors together with quality designs has established a good reputation for our company in the heavy construction industry."

By the standards of the heavy construction industry, ATECO is a small company, having about 160 employees. Its manufacturing facilities in Oakland, California, consist mainly of large machine and welding shops. It buys its castings and forgings, as well as the patterns and dies which are used to make them, from other companies. "We are small," said Mr. Sprenkel, "but our size gives us an advantage in one of the markets for which we design. Bigger companies could not afford to handle contractor's special requests; they need to produce large quantities of an item to make it pay off, while we do not."

As a result of rising labor costs, Mr. Kant feels that there is a good market for rippers. Contractors are continually demanding more powerful equipment, so that they can produce more work per man-hour. This in turn creates a demand for stronger rippers. "The tractors that are being made today would tear apart a ripper that was designed five years ago," said Mr. Sprenkel.

### ATECO Rippers

There are many reasons for wanting to break up rock and other hard materials. Therefore, ATECO makes a number of different types of rippers for different applications. For example, one type of ripper is mounted behind a dozer. The dozer can then be used to either rip earth or push it away. Another ripper is mounted behind a Skid-Shovel. It is used to rip up frozen coal, impacted salt, or some other hard material which can then be loaded in hoppers with the shovel. Rippers are used to increase the speed of a digging operation. For example, one type of ripper is used ahead of a trencher to loosen up the soil and to explore the ground for large obstacles, which can not be removed with the trencher. The obstacles can then be dug or ripped out before the trencher is operated, and thus work shut-downs for the eight man trencher crew can be avoided. Ripping makes the whole operation faster, more economic, and the trencher receives less wear and damage. One variety of ripper is used to bury communication cables; it uses a tube, mounted behind the ripper blade, to feed cable down into the furrow that has been made by the ripper. In this way, one can bury cables in depths up to 12 feet without having to dig an open trench.

There are two basic types of rippers, the "radial lift" and the "parallel lift", and they differ mechanically by the linkages used to raise and lower their cutting teeth. These differences can be seen by comparing Exhibit 2 with Exhibit 3.

Each type of ripper has features that make it the best choice for certain conditions. The radial lift is less complicated and therefore has a lower first cost and maintenance cost. It is able to "down rip" -- that is, it can rip for short distances against a vertical bank -- while a parallel lift cannot. This makes it particularly suitable for ripping in close quarters such as ripping ground for backyard swimming pools.

The parallel lift design allows the cutting teeth to remain at a constant angle with respect to the ground regardless of cutting depth. Therefore, at any ripping depth the teeth are at their most efficient attitude. This is useful when a wide range of materials are encountered, since material properties determine the maximum depth at which a ripper can be operated. The parallel lift frame transmits less vibration to the tractor than does the radial lift. Thus, the parallel lift ripper operator is more comfortable and the operational life of the tractor is extended.

Rippers are subjected to harsh environmental conditions. Dirt can get into pinned joints and form an abrasive mixture with the packing grease. Ripper frames receive shock loadings that can be strong enough to bring 24 ton tractors to a sudden halt. Ripper teeth can wear out in as little as five minutes, and smoke is sometimes seen coming from the ground behind rippers due to the heat generated by abrasion.

"Of all tractor attachments, rippers wear out tractors the fastest due to the shock loadings that they produce," said Mr. Kant. "Rippers themselves are built to withstand shock loading, and a typical ripper will outwear two or three tractors. A tractor's life can be shortened by 30% by using it with a ripper, but the cost of this wear is still a lot less than the cost of blasting in most situations. The cost of ripping can run as low as 20% of the cost of blasting."

"A ripper is one of the few tools that I know of where weight is an advantage," said Mr. Kant. "The downward pressure per square inch on the ripper teeth determines whether or not you can rip a given material. If the pressure is not high enough, the teeth will not penetrate the material. Instead, if you try to force the teeth in with the hydraulic cylinders, the rear end of the tractor will raise up. Thus a tractor can have a high horsepower engine and still not be able to rip."

"Since weight is desirable, we deliberately build our rippers with high weight to strength ratios. The main way that we do this is to build most of a ripper from mild steel (1020). I would estimate that this gives us 50% more weight than if we used high strength steels. In some of our rippers, we have also added scrap metal to hollow parts for added weight."

The ATECO Engineering Department

Two engineers do all of the design work at ATECO. They are assisted by three full time draftsmen and a clerk who sometimes doubles as a draftsman. "We are a small department, and we are kept pretty busy," said Mr. Sprenkel. "Besides designing new rippers, we must make all of the maintenance and installation drawings. We also handle the manufacturing engineering at our plant."

"'Look stout -- be stout' is a principle that guided my group in a lot of our designs in the past," continue Mr. Sprenkel. "Some contractors, particularly the old timers, would say that a ripper looked too light if we were to design it so that it would be just strong enough to do the job. Therefore, we had to over-design things to make them sell. The younger contractors are quite different from the old times, however. They are often college-educated, and 90% of them are inventors. I think that they are sensitive to good engineering design and appearance. It's surprising how smooth lines on a ripper can influence a sale."

"Our salesmen do not like to turn down customer request, so they have kept my group busy with special orders. However, we have found that some of these special request items are really things that a lot of people can use, and they have become standard products at our company."

"A lot of design at ATECO is done by experience rather than by calculation. We can often decide how strong to make a new ripper by determining the percentage increase in tractor power used to pull the ripper. This method isn't infallible, however. The stresses on a new unit might come from a slightly different direction than those on an earlier model. Also, the strength of the earlier model might have been marginal."

"We do not have enough work to warrant hiring a full-time stress analyst, and we have a negative attitude toward hiring one as a part-time consultant. It would take a lot of time for a consultant to acquaint himself with our problems, since our structures are complicated, and their loads are difficult to predict. His services would cost us about \$15 an hour if we hired him from one of the local engineering consultant firms, and we still wouldn't be sure that the part he analyzed would work."

"Caterpillar has stress analysts, and yet they still have part failures. I don't believe that their batting average is any better than ours. They use preliminary stress analysis to determine how small and light they can make their product and thus save money on material. This tends to lead them into borderline strength situations. We try to stay well above that borderline with our designs, and this is a reason why our rippers usually cost more than theirs."

"What our engineering department really needs is better physical testing equipment. By simulating the loadings that will occur in the field, I believe that we will get a far better picture of the strength of our designs than we can get from mathematical analysis. We have some testing

equipment now, but it can only produce static loads. We can apply stresses with hydraulic cylinder and then measure strains with strain gauges. However, it is questionable if these existing tests really indicate actual field stresses."

"Many times we have not had a chance to test our rippers before putting them on the market. Whether or not we test a product usually depends upon the industry's demand for it and upon how different it is from existing models. Being a small company, we want to keep our customers happy. Therefore, we often can't afford to keep a customer waiting for a request while we test it out. We hope that we have overdesigned our products enough so that testing is not necessary. This is almost always the case."

"When we run a field test, we try to pick a location close to our plant so that we can easily monitor it. A rock quarry is usually the best place to test rippers. ATECO does not own any large tractors so we must find a contractor who will test our rippers for us. This is an inconvenience to a contractor and some are not willing to do it. We do not pay a contractor to try out our new rippers, but he does get to use the equipment rent-free. Larger companies have a big advantage in field testing. They can afford to own heavy tractors, which can cost \$100,000 for testing purposes. ATECO cannot do this."

#### Design of a Parallel Ripper

In early 1963, ATECO learned that the Caterpillar Corporation was field testing a new parallel lift ripper (Exhibit 4).

"Except for its size, there was nothing really new about this ripper," said Mr. Sprenkel. "We have been making two types of small parallel lift rippers for a number of years. One of them is called a 'subsoiler', and it is used in agriculture to loosen up soil. Another parallel ripper that we make is a cable layer." (Exhibit 3).

"The construction equipment industry is similar to the automobile industry in that we both are constantly trying to create interest in new designs and make existing designs seem obsolete. We were not very impressed with 'Cat's' design, but they made a lot of claims about the advantages of their ripper. People listen to them because of their reputation as a tractor manufacturer; their tractors outsell all other brands in the Western States."

"The company management decided that we should build a competitive ripper. We had an immediate advantage over Cat in that we knew what their design looked like. Also, we were confident that we would not have to worry about patent infringements, since the Cat design was pretty much a scaled-up version of earlier parallel lift rippers."

"We established several design criteria. First, we wanted to use existing components wherever possible. This would save us time and money,

and we could be reasonably certain that the parts would work. Second, we decided to pattern our design, as much as possible, after our parallel cable layer. We already knew that it would work, so our design problem was reduced, for the most part, to a problem of scaling. The main difference in configuration between the new ripper and the cable plow was that the new ripper would have three teeth while the cable plow had only one. Third, we decided to make our first model fit the Caterpillar D8H tractor (Exhibit 5). The new Cat ripper was also designed to fit this tractor.



Exhibit 1: ATECO Rippers



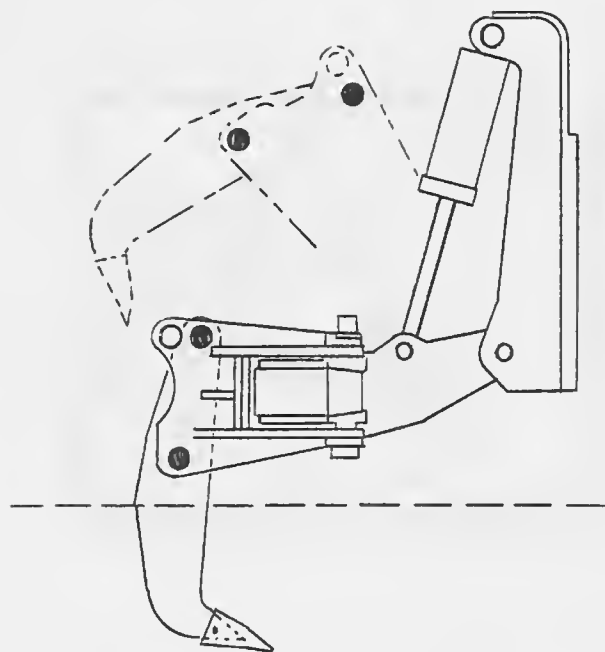
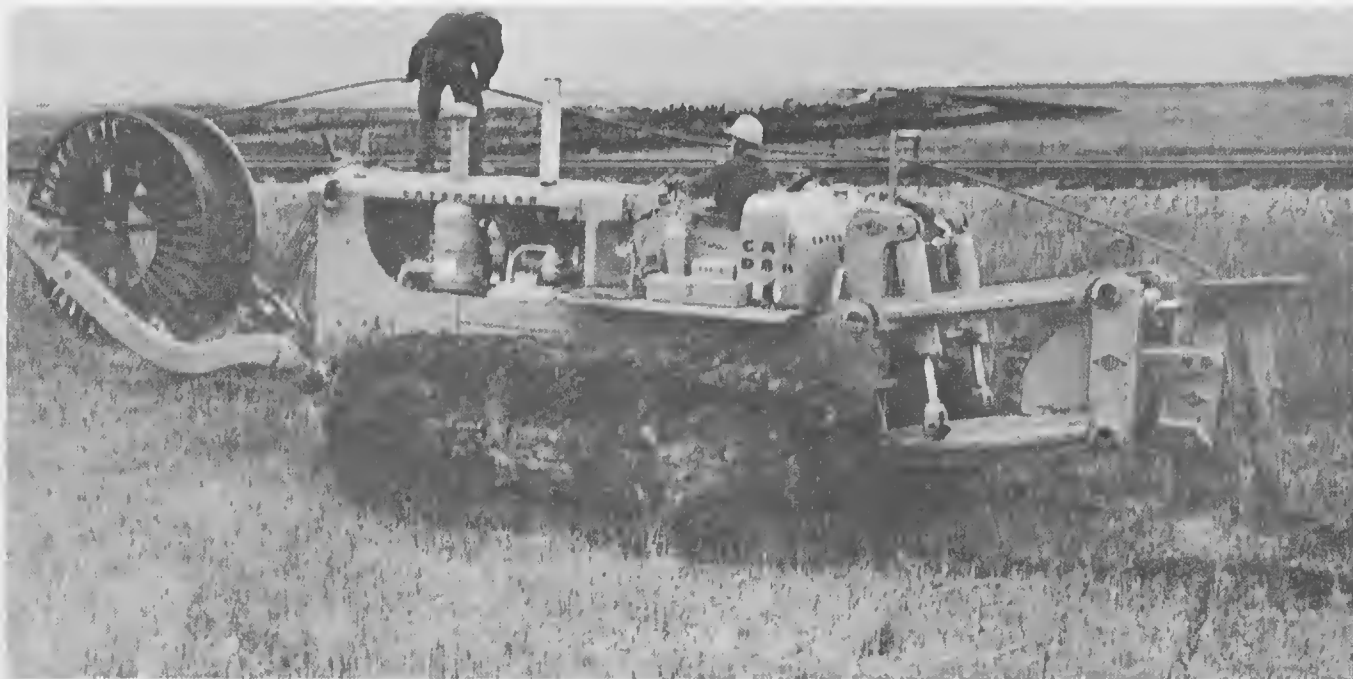
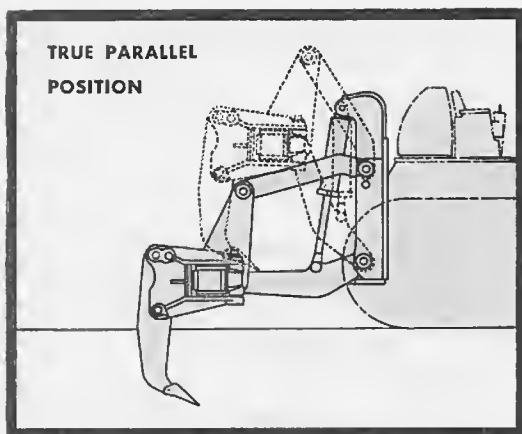
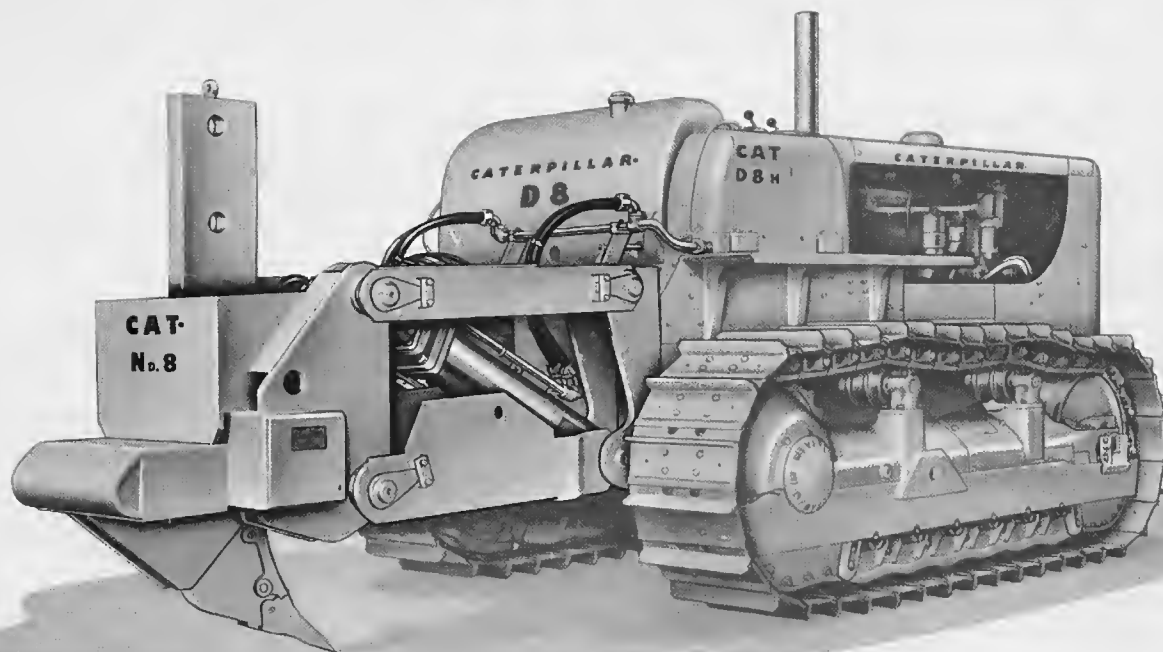


Exhibit 2: Radial Lift Ripper



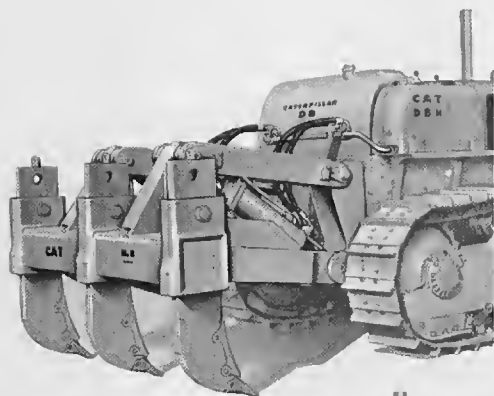
ATECO Parallel Lift Cable Plow, with 72" of vertical shank movement, maintains the correct digging angle at any desired depth and permits a constant plowing depth to be kept when crossing ditches, uneven terrain, etc. Plow shanks are designed for burial depths to 60" and provides 12" ground clearance with the plow in carrying position.

Exhibit 3: Parallel Lift Ripper



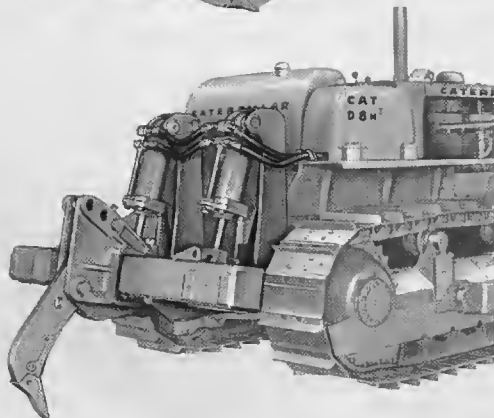
### No. 8B Single Shank Beam, Parallelogram-type —

- Constant shank and tip angle to maximum ripping depth of:  
50" (1270 mm) for standard ripping arrangement  
72" (1829 mm) for deep ripping arrangement
- Four-position standard-ripping shank; six-position deep-ripping shank.
- Push block permits tandem tractor ripping.



### No. 8B Multi-Shank Beam, Parallelogram-type — (End Tooth Groups are Optional)

- Constant shank and tip angle to 31" (787 mm) maximum depth.
- Two-position shank with shank spacing of 3' 10" (1168 mm), total of 7' 8" (2337 mm).
- Beam assembly interchangeable with single shank beam.



### No. 8 Hinge Type; Single, Double or Triple Shank — (End Tooth Groups and Clevises are Optional)

- Differential tip angle manually adjustable up to 30° and 26° (660 mm) maximum depth.
- Five-position shank; clevis with 20° lateral shank swing.

# No. 8

## RIPPER MODELS

**COMPLETE RIPPER** consists of bevel-gear case mounting, hydraulic cylinders, lines, hoses, automatic ripper kickout at full depth and height, beam, clevis\*, shank, shank protector, tip and retaining pins. Beams are welded, box-sectioned, high-strength carbon steel. Clevis is cast alloy steel. Shanks are heat-treated steel plate with preferred fiber orientation. Shank protectors for parallelogram rippers are forged alloy steel; for hinge-type ripper, cast alloy steel. Tips are alloy-steel forgings. Shank Protectors are pinned to shank with two quick-change pins and one stepped pin, all retaining pins are alloy steel.

Caterpillar 183B Hydraulic Control is required but not included in ripper arrangements.

Features common to all four rippers are: Constant-power Hydraulics and Smooth Profile Speed Shanks.

RIPPER MODEL	No. 8 Series B — Single Shank		No. 8 Series B Multi-Shank	No. 8
	Standard Ripping	Deep Ripping***		
TYPE .....	Parallelogram	Parallelogram	Parallelogram	Hinge-type

### STANDARD EQUIPMENT

#### HYDRAULIC CYLINDERS:

Two double acting, bore and stroke .....

7 1/4" x 23"  
(184 mm x 584 mm)

7 1/4" x 23"  
(184 mm x 584 mm)

8 3/4" x 15 1/2"  
(210 mm x 384 mm)

#### BEAM:

Length .....  
Section .....

4' 1 1/4" (1251 mm)  
14" x 15"  
(356 mm x 381 mm)

8' 3 1/4" (2521 mm)  
12" x 12 1/2"  
(304 mm x 317 mm)

9' 2" (2794 mm)  
11" x 11"  
(279 mm x 279 mm)

**CLEVIS\*** (one is standard, 2nd and 3rd are optional)

Swivel (to each side of center) .....

10°

#### SPEED SHANK WITH SHANK PROTECTOR (one is standard, 2nd and 3rd are optional):

Shank positions .....  
Length, with tip .....  
Section .....

87" (2210 mm) 109" (2769 mm)  
3 1/2" x 14"  
(89 mm x 356 mm)

66" (1677 mm)  
3" x 13"  
(76 mm x 330 mm)

58 1/2" (1476 mm)  
3" x 10"  
(76 mm x 254 mm)

#### TOOTH TIP\*\*:

Depth of penetration, maximum.  
Length .....

50" (1270 mm) 72" (1829 mm)  
10 1/2" (267 mm) 9" (229 mm)  
Intermediate Tip Short Tip

31" (787 mm)  
10 1/2" (267 mm)  
Intermediate Tip

26" (660 mm)  
10 1/2" (267 mm)  
Intermediate Tip

#### DIMENSIONS:

Tractor with ripper,  
Length, ripper up .....  
ripper down .....  
Width .....  
Beam-Ground Clearance  
Beam up .....  
Beam down .....

22' 4 1/4" (6814 mm)  
23' 11" (7290 mm)  
9' 2" (2794 mm)

20' 4 3/4" (6217 mm)  
21' 11 1/2" (6693 mm)  
9' 2" (2794 mm)

21' 0" (6406 mm)  
21' 3" (6477 mm)  
9' 2" (2794 mm)

64 1/2" (1640 mm)  
12" (300 mm)

64 1/2" (1640 mm)  
12" (300 mm)

41" (1040 mm)  
11 1/2" (290 mm)

#### SHIPPING WEIGHT (approx.),

Ripper installed..... 9,800 lb. (4450 kg) 10,300 lb. (4650 kg) 9,100 lb. (4150 kg) 6,500 lb. (2950 kg)

### OPTIONAL ATTACHMENTS

**EXTRA TEETH** (one or two additional) includes: clevis\*, speed shank, shank protector, intermediate tip and retaining pins.

	No. 8B Multi-shank		No. 8 Hinge-type	
Number of teeth, total.....	2	or 3	2	or 3
Tooth spacing .....	7' 8" (2337 mm)	3' 10" (1168 mm)	7' 8" (2337 mm)	3' 10" (1168 mm)
Weight, complete ripper.....	10,400 lb. (4750 kg)	11,150 lb. (5060 kg)	8,200 lb. (3700 kg)	9,400 lb. (4260 kg)

#### TOOTH TIPS:

Long length ..... 12" (305 mm)  
Short length ..... 9" (229 mm)

**HYDRAULIC PIN PULLER\*\*\*** includes hydraulic system (for No. 8B Single Shank Standard Ripping Arrangement only)

Weight, Installed: Power Shift..... 140 lb. ( 64 kg)  
Direct Drive..... 225 lb. (102 kg)

\*Hinge-type Ripper only

\*\*\*Standard with No. 8B Single Shank Deep Ripping Arrangement

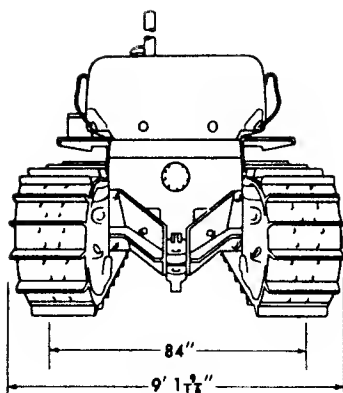
\*\*Caterpillar Tooth Tip Types:

Short — for severe high shock duty. Intermediate — for medium shock and abrasive duty. Long — for low shock, high abrasion duty.

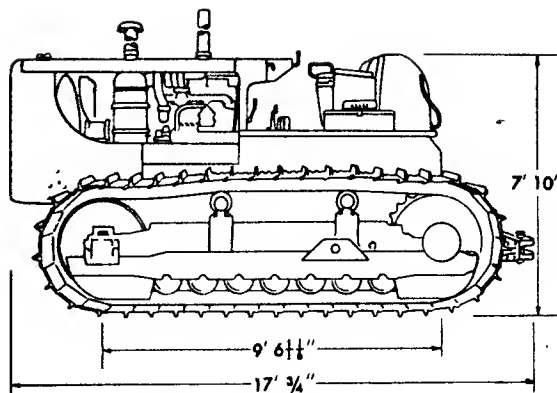
Materials and specifications are subject to change without notice.

# CATERPILLAR

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.



Ground clearance .....19 3/4"  
Drawbar height .....20 3/4"



SHIPPING WEIGHT, lbs.:  
Power Shift ..... 48,210  
Direct Drive ..... 47,180

**D8H Power Shift** **235 HP (Flywheel)**

**SPECIFICATIONS**

Engine: Heavy duty, four-cycle, turbocharged, diesel, Model D342  
Horsepower (flywheel) ..... 235  
Number of cylinders ..... 6  
Bore & stroke ..... 5.75" x 8"  
Piston displacement (cu. in.) ..... 1246  
RPM-governed at full load ..... 1240

Transmission ..... Caterpillar-built Power Shift  
Speed Range MPH

Gear	1	2	3
Forward	0-2.4	0-4.2	0-6.5
Reverse	0-3.0	0-5.2	0-8.0

Steering Clutches ..... Oil-type, multiple disc  
Hydraulically actuated

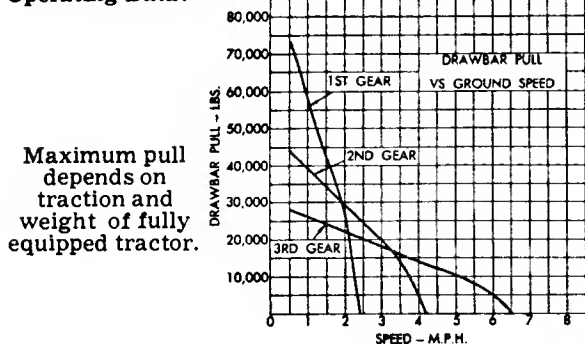
Brakes ..... Oil-type, contracting band  
Hydraulically boosted

Undercarriage:  
Width of standard track shoe ..... 22"  
Number of rollers (each side) ..... 6 - option 7  
Number of shoes (each side) ..... 39  
Ground contact area with 22" shoes  
(sq. in.) ..... 5050  
Adjustment ..... Hydraulic

Starting ..... Gasoline starting engine  
with 12 volt electric in-seat start

Fuel Tank Capacity: U.S. Gallons ..... 134

**Operating Data:**



**D8H Direct Drive** **235 HP (Flywheel)**

**SPECIFICATIONS**

Engine: Heavy duty, four-cycle, turbocharged, diesel, Model D342  
Horsepower (drawbar) ..... 185  
Number of cylinders ..... 6  
Bore & stroke ..... 5.75" x 8"  
Piston displacement (cu. in.) ..... 1246  
RPM-governed at full load ..... 1200

Transmission ..... Caterpillar-built Direct Drive

Steering Clutches ..... Oil-type, multiple disc  
Hydraulically actuated

Brakes ..... Oil-type, contracting band  
Hydraulically boosted

Undercarriage:  
Width of standard track shoe ..... 22"  
Number of rollers (each side) ..... 6 - option 7  
Number of shoes (each side) ..... 39  
Ground contact area with 22" shoes  
(sq. in.) ..... 5050  
Adjustment ..... Hydraulic

Starting ..... Gasoline starting engine with  
12 volt electric in-seat start

Fuel Tank Capacity: U.S. Gallons ..... 134

**Operating Data:**

Travel Speeds at Rated Engine RPM	Transmission Gear	Drawbar Pull (lb.)	
		Rated	Maximum
1.5	1	44,400	53,150
1.9	2	34,500	40,150
2.7	3	24,100	28,150
3.5	4	17,750	20,850
4.6	5	13,000	15,400
6.3	6	8,450	10,200
Reverse			
1.5	1	43,700	52,450
2.0	2	33,900	39,450
2.7	3	23,700	27,700
3.6	4	17,400	20,450
4.6	5	12,700	15,050
6.4	6	8,250	10,050

Maximum pull depends on traction and weight of fully equipped tractor.

April 10, 1964

D8H-3

D8H-4

April 10, 1964

Printed in U.S.A.

1. Comment on: "Look stout -- be stout", "overdesign", and ATECO design practice.
2. A consulting rate of \$15/hr is quoted (1965). What rate would you expect today?
3. Comment on ATECO field testing procedure. Make recommendations for an improved procedure and estimate the cost.
4. What would your design of the new ripper look like? What sort of performance would you predict for their's, for your's?

## AMERICAN TRACTOR EQUIPMENT CORPORATION (B)

## Testing of a Parallel Lift Ripper

In a six month period, ATECO designed and built 30 large parallel lift rippers. The Caterpillar ripper had been on the market for only two months at the end of this period. ATECO then faced the decision of either testing one of their new models or putting them directly on the market.

"Since we felt that we had over-designed our ripper, and since many of its parts were existing components from other rippers, we believed that there was little reason to test it as a prototype," said Mr. Sprenkel. "We weren't worried about anything breaking, but we were slightly concerned over whether or not our hydraulic cylinders would be powerful enough to pull boulders out of the ground. We also wondered if our sales points were real ones (Exhibit 1)."

"We finally did decide to test one of the rippers. ATECO loaned one to a contractor who was working near Tracy, California, for three months and told him to use it in the same way that he used his other rippers. About once a week the company president, the vice president, or I would go to the construction site and inspect our ripper. We would watch it operate for a while, inspect it for cracks and hydraulic leaks, and interview the operator."

"Soon after our test began, two problems appeared. The hydraulic cylinders were not strong enough to pull the ripper teeth up when they were hooked around a rock. We substituted heavier cylinders and found that they corrected the problem. Cracks developed at two points in the ripper draft frame (Exhibit 2). Again the source of trouble was fairly obvious; two sharp bends in a metal strap were acting as stress raisers. We welded another strap to the defective one as a reinforcement on our 30 original rippers (Exhibit 3) and decided to use a curved strap on subsequent models (Exhibit 4). This solution worked, and no further troubles were encountered in the test period. After three months of testing, we decided that our ripper was ready to go on the market."

After what was considered a successful test, a number of the new parallel rippers were sold. A few weeks later Mr. Sprenkel began to receive telephone calls and service reports (Exhibit 5) informing him that cracks were developing in a part of the ripper draft frame. "The approach to solving this problem was fairly obvious," said Mr. Sprenkel. "There were some stress concentrations that had to be reduced, and the material in the area of the failure had to be made stronger."

"We talked with the contractor who had tested our ripper and discovered that he had used it with only one cutting tooth. The ripper is capable of holding as many as three teeth on its tool beam and when more than one tooth is installed, the loading on the ripper frame is considerably different. If the ripper is operating with two teeth, one of the teeth may hit a rock while the other one is still in loose soil. When this happens, torques are produced on the ripper frame, and these torques probably account for the failure."

"We knew that we could redesign the draft frame so that it would work. Our real problem was a lack of time. The contractors who owned the defective units were losing money by not being able to use them: 'down time' is very expensive in the heavy construction industry. Also, we had to stop selling the rippers then in stock, and orders were piling up."



# 6 exclusive reasons why an Parallel Lift Ripper is your best buy

**EXCELLENT  
OPERATOR  
VISIBILITY**



**CYLINDERS  
READILY  
ACCESSIBLE**

for maintenance,  
yet well protected  
from damage.

**DRAWBAR IS  
RETAINED**

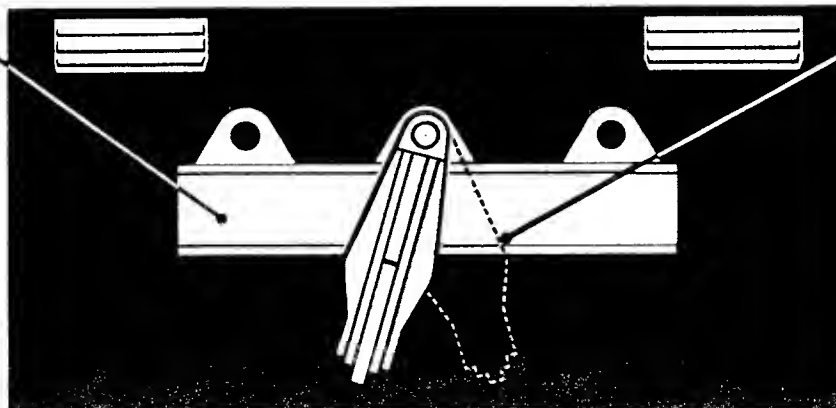
and accessible  
for towing.

**ADJUSTABLE  
FOR MODIFIED  
OR TRUE  
PARALLEL LIFT**

Modified position maintains a constant point angle at normal ripping depths, but rapidly increases the angle at ground level and upwards. Gains easier penetration in tough materials, extends point life, and secures 6" greater ground clearance and 12" greater clearance between tractor and point... lets you roll out big slabs without jamming, keeps material from breaking up under tracks.

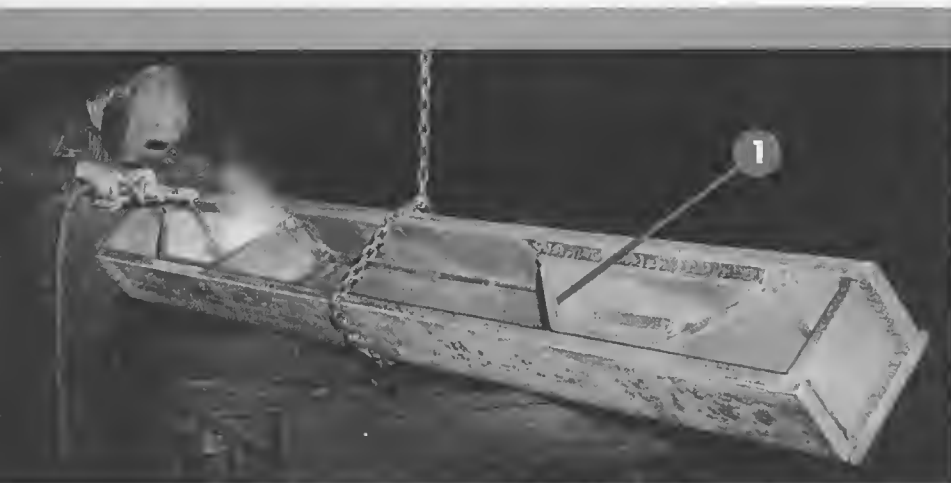
**NARROW  
TOOL  
BEAM**

Narrow tool beam locates shanks inside the track gauge for easier steering and better traction, yet permits toe ripping with outer shanks. The helping action of the closely spaced shanks greatly increases production on the tough jobs — increases track life and reduces wear and tear on steering clutches and brakes.



**SHANK  
BRACKETS  
SWIVEL A  
FULL 30°**

Shank brackets swivel a full 30° for effortless steering and to prevent excessive strain on tractor and ripper. The shank brackets pivot on extra large pins allowing shanks to always face into the load, preventing dangerous side loading — aids in following cracks or weak spots in the material, lifting and breaking rock or prying out embedded boulders.

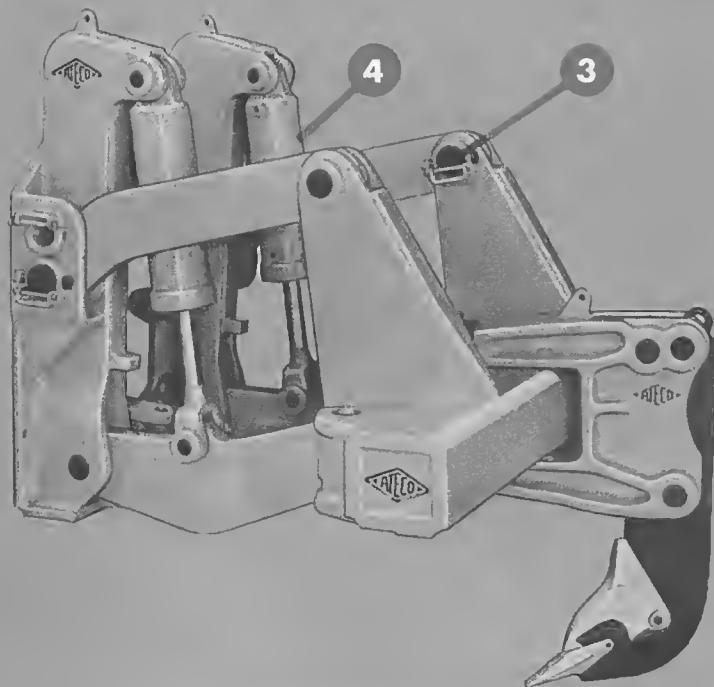


## hidden quality...

Look under the Paint—See why ATECO tool beams take more abuse. This ripper tool beam is designed to take terrific torsion loads in any direction. Internal angle reinforcing of 2" steel plate (item 1) is properly spaced and thoroughly welded for maximum strength and rigidity. Note extra heavy welds inside and outside of beam, two-pass machine welded—no guess work. Solid steel takes the compression load and stresses.



ATECO rippers stay put when the going gets tough—every component is built for a life of abuse, not to meet a low price, but for dependable, continuous service. The shank brackets pivot about on extra large pins in a very heavy bearing (item 2) which has renewable bushings in both top and bottom with built-in grease reservoir.



## extra value features

ATECO rippers are correctly mounted to take the hydraulic lift and down pressure plus the tractor's weight on the support brackets. For extra mounting safety ATECO supplies additional mounting studs to those already provided in the tractor case. All studs are heat-treated and Hi nuts are case hardened to prevent galling of threads. Only extra large, heat-treated, alloy steel pins and replaceable bushings (item 3) are used at all hinge points. The extra heavy wall cylinders (item 4) use self lubricated urethane and buna packing assuring a perfect seal and longest service life.

## AMERICAN TRACTOR EQUIPMENT CORPORATION

9131 San Leandro Street, Oakland, California 94603  
*factory*

4535 - 25th Ave., Schiller Park, Illinois 60176 (Chicago Suburb)  
*factory branch*

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# HPR-D9G & HPR-D8H

## PARALLEL LIFT

# RIPPER

### FOR CATERPILLAR D9G & D8H TRACTORS

## SPECIFICATIONS



## features...

**ADJUSTABLE POSITIONS** - for modified parallel lift and true parallel lift.

**MODIFIED POSITION** - changes point angle at ground line to best penetrating angle - changes to best ripping angle at working depths. Points penetrate faster - stay sharp and last longer.

**LIFTING ACTION** - when ripper is raised rolls large rocks up and out in the clear behind ripper.

**SHANK AND POINT** - maintains excellent tractor clearance - doesn't crowd tractor when raised.

**CYLINDERS** - mounted up out of the rock area - there's no danger of cylinders being damaged from moving objects - easily accessible for inspection and maintenance.

**EXCELLENT OPERATOR VISIBILITY** - results in increased efficiency and safety.

**NARROW TOOL BEAM** - locates shanks inside the track gauge for easier steering and better traction - increases track life and reduces wear and tear on steering clutches and brakes.

**SWIVEL MOUNTED SHANKS** - follows tractor like a trailer.

**DESIGNED FOR TANDEM PUSHING** - takes the rough, tough jobs in stride.

## SPECIFICATIONS

**AMERICAN TRACTOR EQUIPMENT CORPORATION**

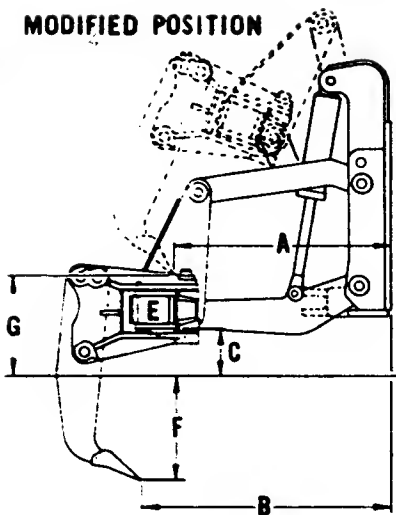
9131 San Leandro Street, Oakland, California 94603  
*factory*

4535 - 25th Ave., Schiller Park, Illinois 60176  
*warehouse* (Chicago Suburb)

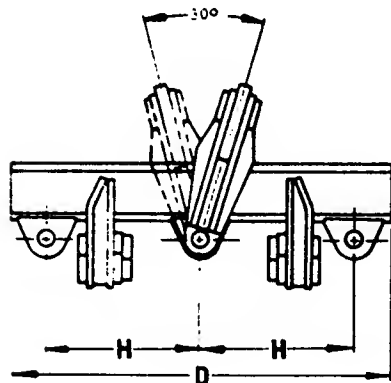
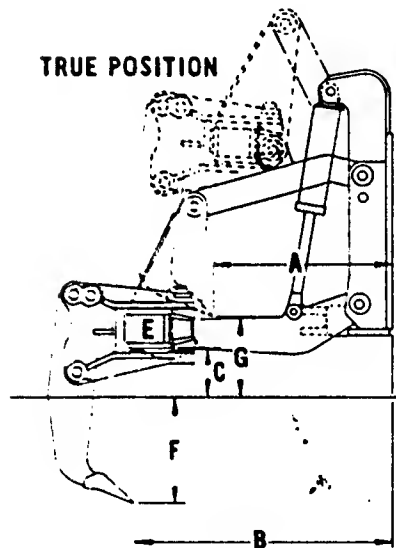
# Specifications

## PARALLEL LIFT RIPPER

### MODIFIED POSITION



### TRUE POSITION



### RIPPER MODEL

#### DESIGNED FOR

Tractor Make -  
Tractor Model -

### HPR-D9G

Caterpillar  
D9, Series G

### HPR-D8H

Caterpillar  
D8, Series H

#### DIMENSIONS

Ripper Raised:	Modified Position	True Position	Modified Position	True Position
Length with Tractor -	22' 9"	22' 3"	21' 1"	20' 5"
Length behind Tractor -	7' 7"	7' 1"	6' 8"	6' 0"
Length - Rear Case to Point Tip (A) -	6' 2"	5' 3"	5' 4"	4' 3"
Ripper Lowered:				
Length - Rear Case to Point Tip (B) -	6' 10"	6' 10"	6' 1"	6' 1"

#### TOOL BEAM

Construction, Type of	Boxed Internally Reinforced Steel	Boxed Internally Reinforced Steel
Material	Steel	Steel
Clearance under Beam:	Modified Position	True Position
Ripper Raised	69"	67"
Ripper Lowered (C)	14"	14"
Length Overall (D)	92"	92"
Cross Section (E)	12-1/2" X 14"	11" X 12-5/8"

#### SWING BRACKET

Construction, Type of	Cast Steel	Cast Steel
Pivot Pin Diameter	4"	3-1/2"
Swing Degree, each side	15°	15°
Adjustment Provisions	Pitch and Depth	Pitch and Depth

#### SHANKS

Varieties	Straight and Curved	Straight and Curved
Material:		
Straight Shank	Forged Nickel Alloy Steel	Forged Nickel Alloy Steel
Curved Shank	Cast Alloy Steel	Cast Alloy Steel
Maximum Number Usable	3	3
Attachment Method	Pin 3-1/2"	Pin 3"
Actual Penetration: (F)		
Type 4 Straight Shank (24" Nominal)	26"	26"
Type 4 Straight Shank (28" Nominal)	30"	30"
Curved Shank (24" Nominal)	24"	24"
Type 96 InTrLok H Str. Shank (28" Nominal)	28"	28"
Type 96 InTrLok H Str. Shank (42" Nominal)	42"	42"
Type 96 InTrLok H Str. Shank (48" Nominal)	48"	48"
Ground Clearance: (G)	Modified Position	True Position
24" Type 4 Straight Shank	35"	27"
28" Type 4 Straight Shank	32"	24"
24" Curved Shank	39"	30"
28" Type 96 InTrLok H Straight Shank	34"	26"
42" Type 96 InTrLok H Straight Shank	21"	12"
48" Type 96 InTrLok H Straight Shank	16"	6"
Shank Spacing Center to Center (H)	37"	37"

#### POINTS

Type of	One Piece Renewable Pin	One Piece Renewable Pin
Attachment Method	Pin	Pin
Material	Forged Nickel Alloy Steel	Forged Nickel Alloy Steel
Optional Varieties	Yes	Yes

#### HYDRAULIC SYSTEM

Type Required	ATECO Hydraulic Controls or Cat Hydraulic Controls	ATECO Hydraulic Controls or Cat Hydraulic Controls
Location on Tractor (ATECO)	Pump Driven from Rear Engine Power Take-off Shaft, Rear Mounted Valve, Tank and Controls	Pump Driven from Rear Engine Power Take-off Shaft, Right Hand Fender Mounted Valve, Tank and Controls
Pump:		
Type of	Gear	Vane
Capacity	73 GPM - 1000 PSI	65 GPM - 1000 PSI
Valve:		
Type of	Spool	Spool
Positions	Raise, Lower, and Hold	Raise, Lower, and Hold
Number of Spools	2	1 or 2
Cylinders:		
Number of	2	2
Bore	9-1/8"	8-1/8"
Stroke	19-7/8"	19-7/8"
Rod Diameter	3"	3"
Hydraulic Lines:		
Hose	High Pressure with Renewable Fittings	High Pressure with Renewable Fittings
Fittings	Flange O-ring Type	Flange O-ring Type

#### SHIPPING WEIGHTS

With 3-28" Type 4 Straight Shanks	17,861#	13,175#
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Specifications subject to change without notice.

#### CONVERSION TABLE

1 Inch = 2.54 Centimeters	1 U. S. Gal. = 3.785 Liters	1 lb. = .4536 Kilogram
1 Foot = 30.48 Centimeters	1 U. S. Gal. = 0.833 Imp. Gals.	

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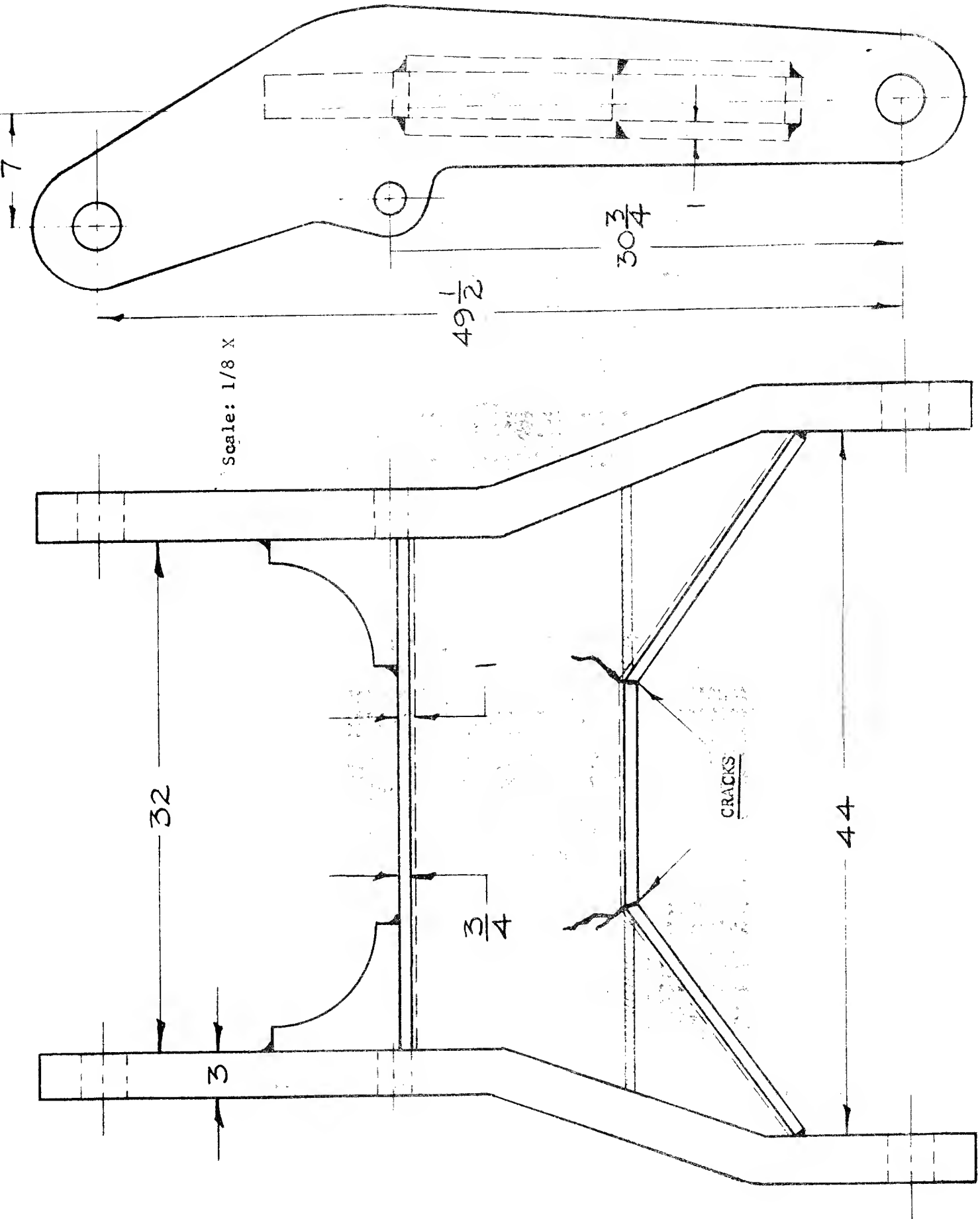


Exhibit 2: Ripper Draft Frame #1 (for location of this part, see Exhibit 1)

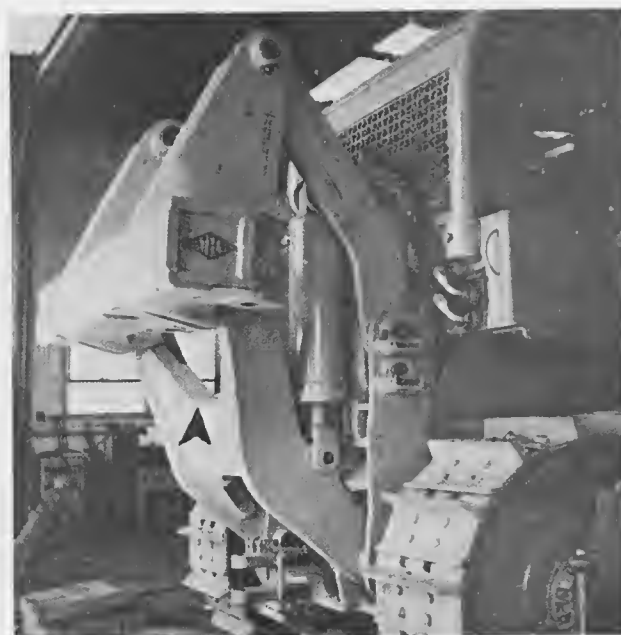


Exhibit 3: Draft Frame with Reinforcing Strap Installed

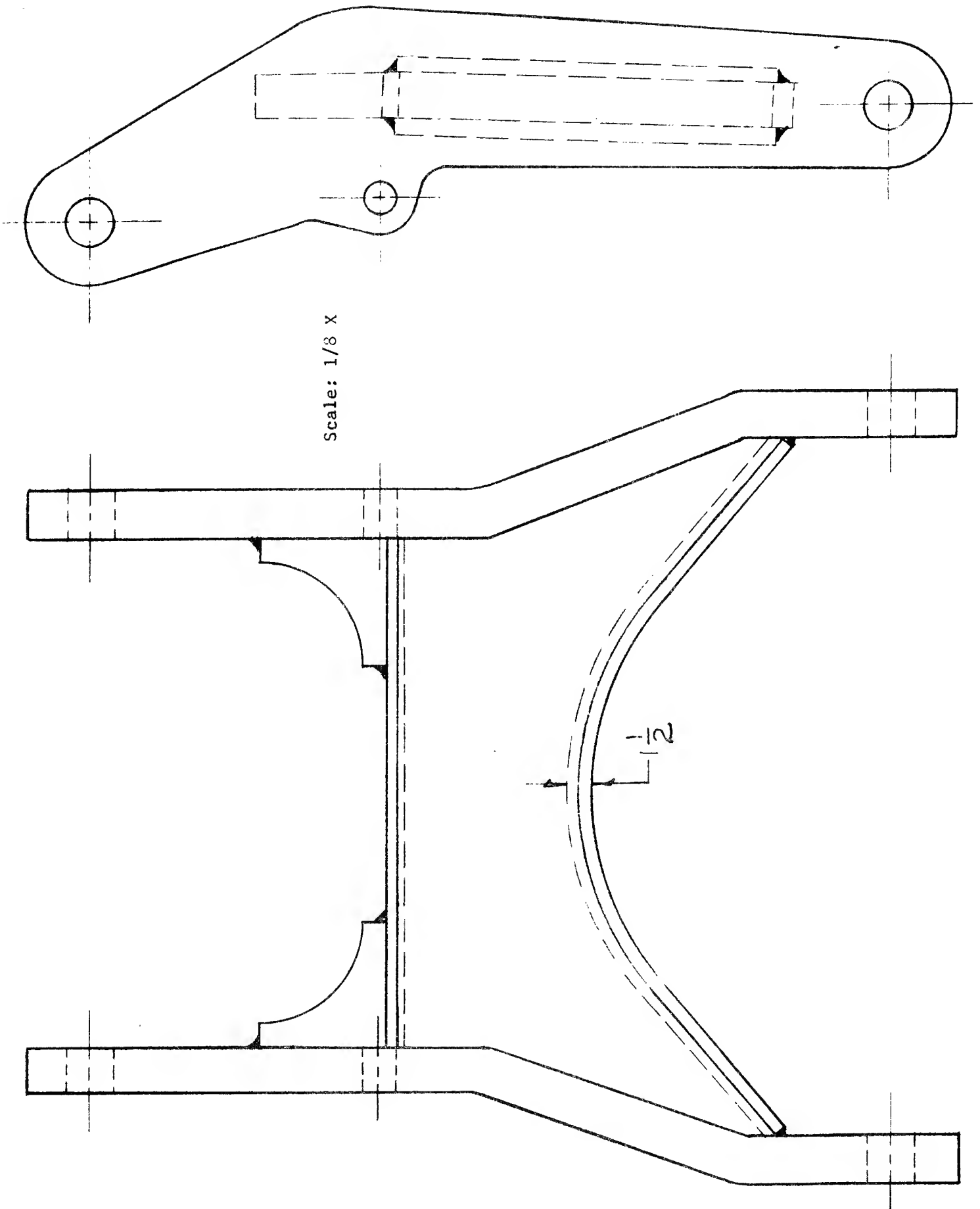


Exhibit 4: Ripper Draft Frame #4

July 13-14-64

ECL 40-B  
Exhibit 5

# SERVICE REPORT

## PARTS DAMAGED

MODEL H.P.R.D.9. . .

REPORT REC'D . . . . . SERIAL 14093 ? . .

*Draft Frame Cracks*

HOURS SERVICE . . . . . SHIPPED . . . . .

INFO. POSTED . . . . . DELIVERED . . . . .

REC'D. BY . . . . . OCCURRED . . . . .

DEALER . . . . . ATT . . . . .

ADDRESS . . . . . PHONE . . . . .

OWNER . . *J.A. Thompson Co.* . . . . . ATT . . . . .

ADDRESS . . . . . PHONE . . . . .

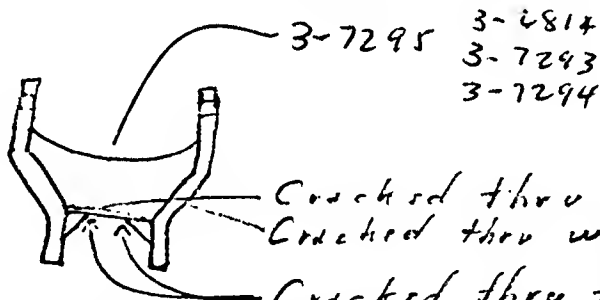
JOB LOCATION . *Thousand Oaks* . . . . . ATT . . . . .

OPERATION . . . . . PHONE . . . . .

## COMPLAINT & CORRECTION TAKEN

ROUTING	
DW	<input checked="" type="checkbox"/>
AK	<input type="checkbox"/>
<i>Roger</i>	<input checked="" type="checkbox"/>
	<input type="checkbox"/>
	<input type="checkbox"/>
	<input type="checkbox"/>

*Draft frame assembly cracked (3) places.*



*Cracked thru weld, full length. Top.*

*Cracked thru weld, 1/2 length. Bottom.*

*Cracked thru flat bar, next to welds.*

*Cracks field welded. Left side cracked thru weld.*

*Left side cylinder failed at top head weld. Weld cracked all around.*

*Gauged out, & welded in field.*

*Weld on right side cylinder top head looks light.*

*New re-designed draft frame assembly, & (2) new cylinders to be shipped to jobsite.*

**REPLACED DRAFT ASM 3-6808-2 BY 3-6808**

Exhibit 5: Company Service Report

Obviously, you (ATECO and/or Mr. Sprenkel) have a serious problem. Time is money and you are losing both. You need to solve the failure problem and get your product (including the inventory) on the market. Over-designed, or not, a new (or altered) design is in order.

1. Devise a "quick fix" which will keep customers happy on a short term basis.
2. Re-design (or develop a new design) which will provide a permanent answer or solution.
3. Provide drawings (sketches) as appropriate and indicate why you think your design is an improvement which will function without failures.

## AMERICAN TRACTOR EQUIPMENT CORPORATION (C)

## Corrective Design for a Ripper Draft Frame Failure

"As a temporary measure, we designed some reinforcing plates that could be welded to the defective units (Exhibit 1). These were installed at our plant on the rippers then in stock and installed on the rippers that had been sold while they were still in the field. Since we were in a hurry to correct the failures, this 'fix' was installed without any tests. A few of the 'fixes' broke, but most of them worked; again we were relying upon experience."

"By selling units with the 'fix' installed, we were able to handle the backlog of orders. It also gave my engineering department sometime with which to come up with a better redesign. The 'fix' was ugly, and, though it worked, many contractors would not buy it just on the basis of appearance."

"While units with the 'fix' installed were being sold, we designed an entirely new draft frame (Exhibit 2). The new design avoided the sharp corners which had acted as stress raisers in our earlier designs. We also felt that the new design was capable of withstanding greater torques brought about by uneven loading on the ripper teeth."

"Before marketing this new frame, we gave it some static tests. We fastened three of the pinned joints on the frame to a test stand and applied pressure to a fourth joint with a hydraulic cylinder (Exhibit 3). In effect we simulated a condition where all of the force applied to the ripper teeth was concentrated on one tooth mounted on one end of the ripper beam. Our calculations showed that the maximum static force that could be generated at a tooth by the combined weights of the ripper and tractor was 50,000 pounds."

"The two joints on the frame that connected it to the two ripper hydraulic cylinders were not fastened to the test stand since they normally do not produce torque loadings on the draft frame. The hydraulic cylinders are connected by a hydraulic hose, and, therefore, their fluid pressures are always the same. Therefore, both cylinders will usually exert the same amount of force on the frame and thus produce no torque. There are, however, two unusual situations when the cylinder can produce a torque. These occur when one of the cylinders is either fully extended or fully retracted. Since these situations are very unusual, we did not take them into account in our tests."

"In our first test, we found that a load of 50,000 pounds produced no permanent deformation in the frame. In a second test, we applied a 65,000 pound load, which gave us a safety factor of 30%. This produced a three inch deformation and a 3/4 inch set at the point where the load was applied. On a basis of past experience, we felt that this deformation was too high, so we increased the thickness of the draft frame box from five to six inches (see Exhibit 2). We tested a frame with the redesigned box and found that the amount of permanent deformation was reduced to an acceptable 1/4 inch."

"The draft frames used in our tests were coated with a brittle stress paint, and the tests produced visible cracks in the paint along the lines of constant stress. The pattern of these cracks showed us that we had removed the troublesome stress concentrations (Exhibit 4)."

"Looking back now, I can see that we should have avoided some stress concentration points. Unfortunately, the structures that we are working with do not lend themselves to analysis. The shapes are complicated and the loading is hard to predict. A man really schooled in stress analysis might have found that the draft frame would break. Then again, he might not have, and we would have spent a lot of money for his opinion."

"Our management was pretty mad that the failure occurred, but their feelings were tempered by the fact that the prototype test was successful. We took care of the failure quickly and with little or no cost to the contractors. I think that this action actually created good will with the contractors who already knew of our company."

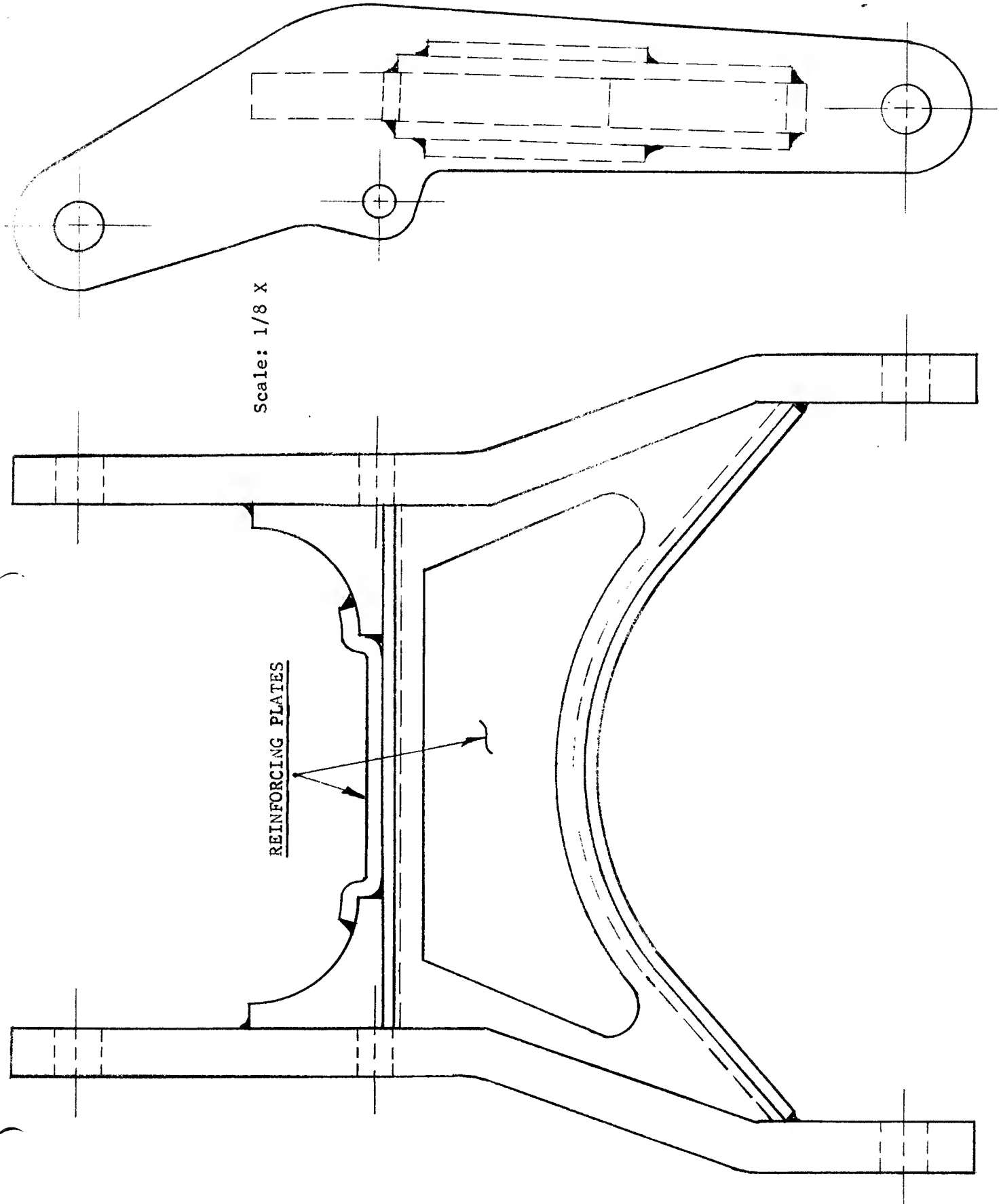


Exhibit 1: Ripper Draft Frame #3

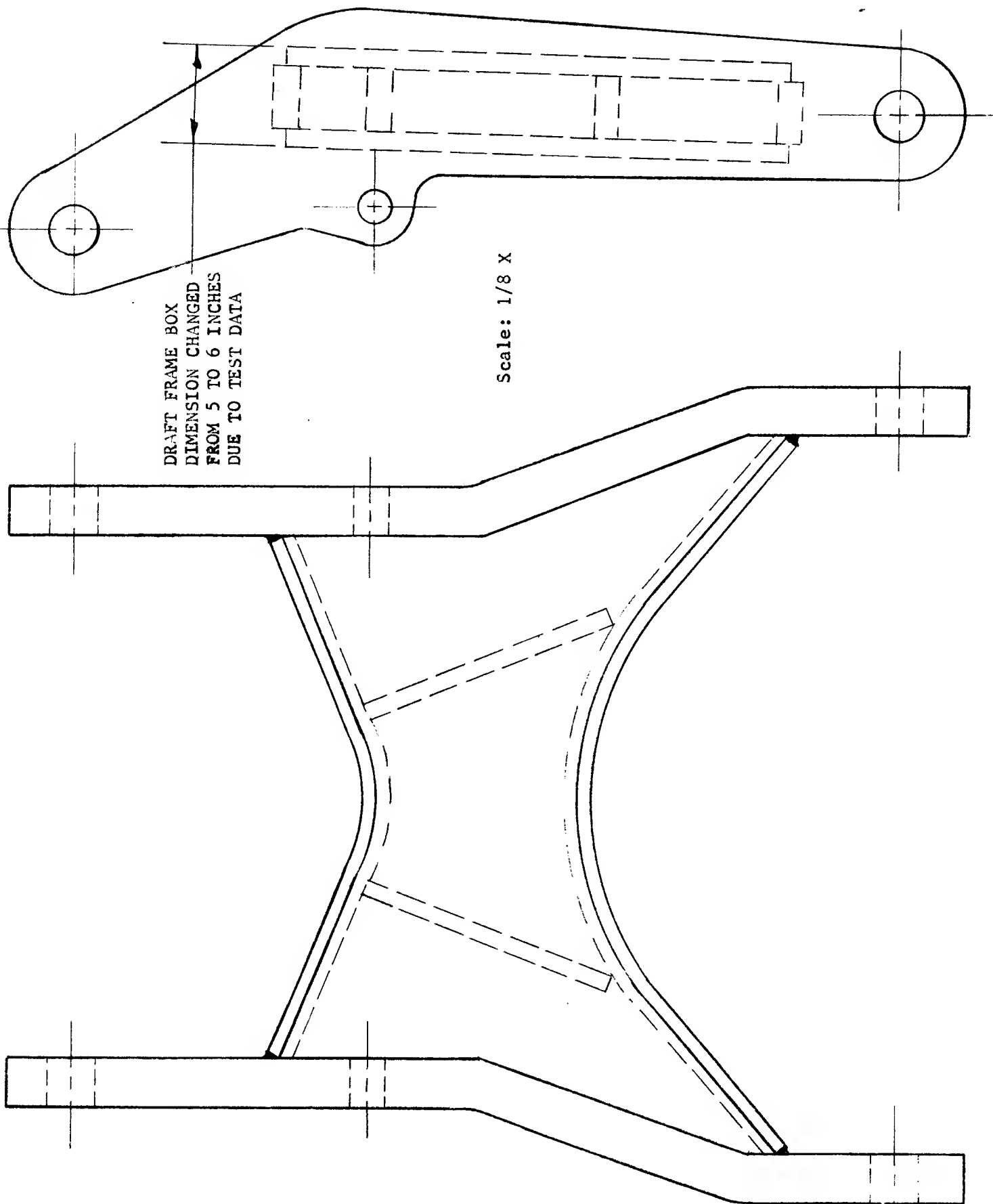


Exhibit 2: Paper Draft Frame #4

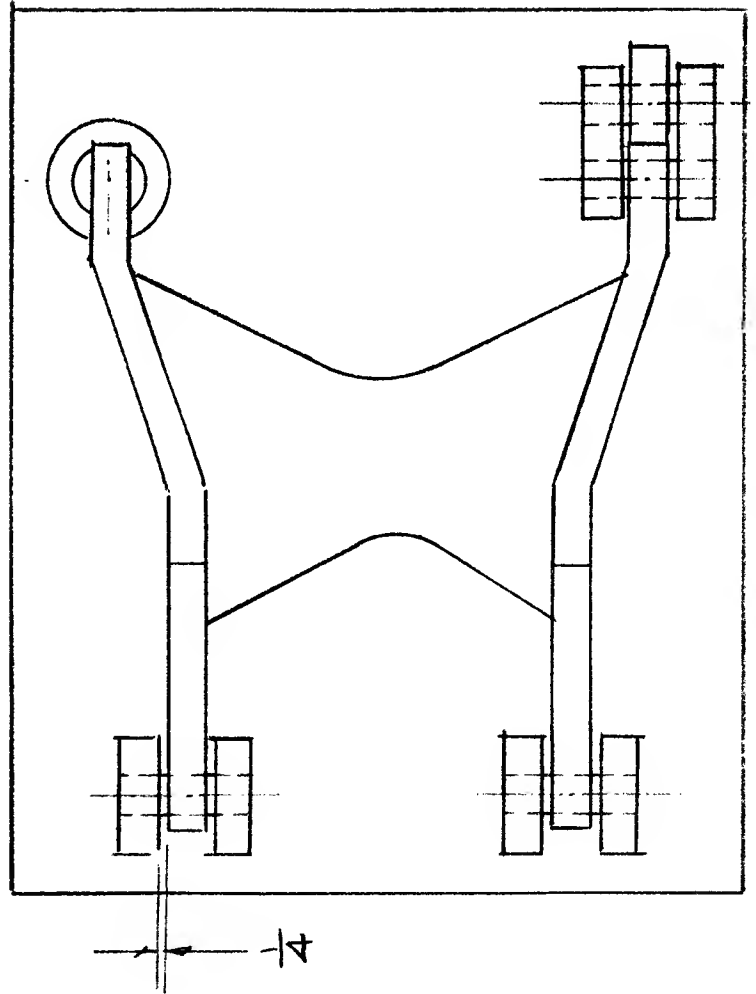
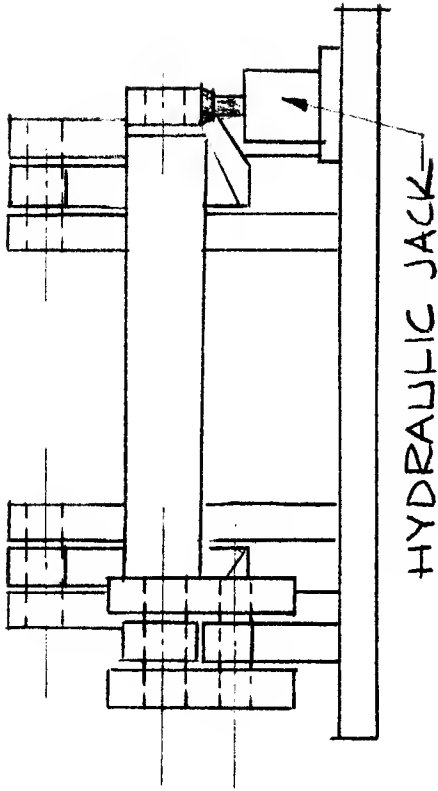
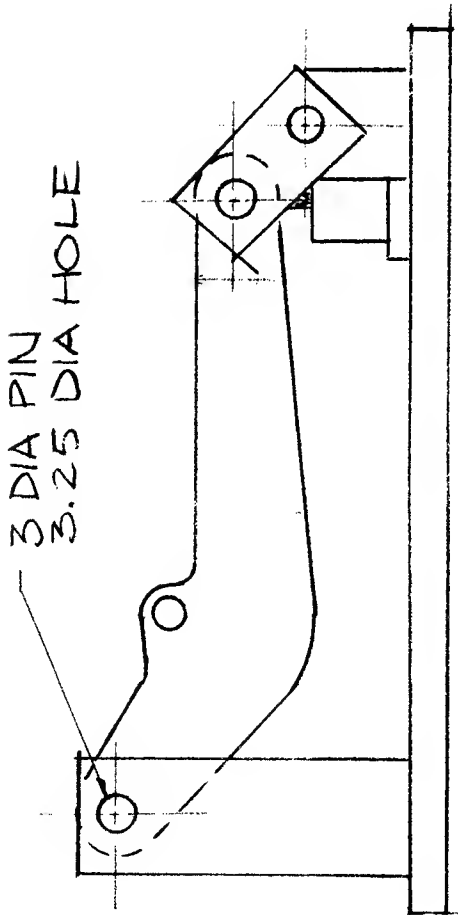


Exhibit 3: Draft Frame Test Stand

CRACKS IN STRESS PAINT



Exhibit 4: Draft Frame Test with Brittle Stress Paint